PATENT ABSTRACTS OF JAPAN

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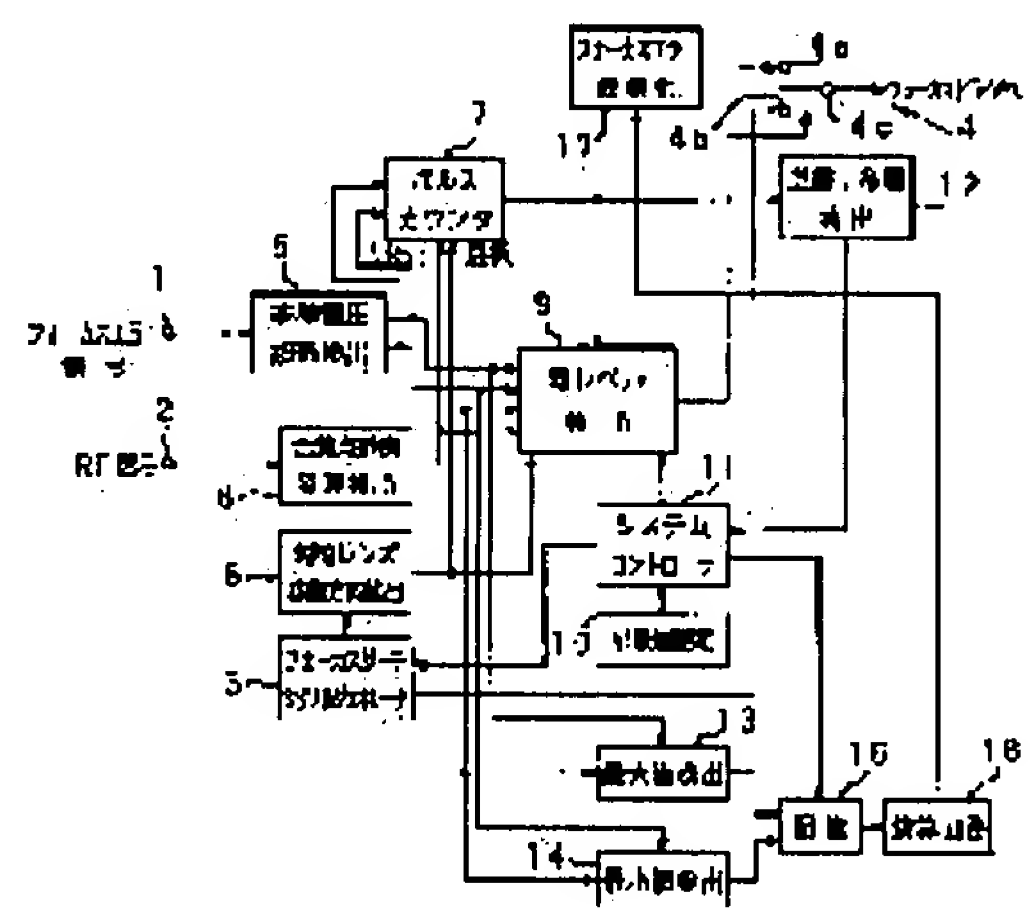
(71)Applicant : **SONY CORP**
(72)Inventor : **TANAKA SHINTARO**
SAEKI HIROSHI

(54) **FOCUS CONTROLLER**

(57)Abstract:
PURPOSE: To accurately perform the focusing to a required recording layer of a multilayered optical disk and to perform an accurate focus servo by adjusting the level of a focus error signal supplied from the outside.
CONSTITUTION: An objective lens moving direction detection circuit 8 detects the moving direction of an objective lens 26 based on the polarity of a focus moving signal from a generator 3 at the time of a focus search mode to send the detected signal to a pulse counter 7 and a zero level detection circuit 9. A count value, two comparison pulses, the detection signal, the detection signal and the recording layer specification data are supplied respectively from a counter 7, a reference voltage excess detection circuit 5, a focusing point vicinity arrival detection circuit 6, a detection circuit 8 and a system controller 11 to the circuit 9. Thus, the levels of the focus error signals are detected for every recording layer, and the fluctuation of the focus error signals different at every disk or recording layer are corrected according to the detected levels.



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CLAIMS

[Claim(s)]
[Claim 1] The recording layer assignment means for specifying the recording layer of the request which performs focal doubling of the optical disk with which it comes to carry out the laminating of two or more recording layers, If a desired recording layer is specified by the above-mentioned recording layer assignment means, in the phase of performing focal doubling to the recording layer by which the focal doubling control means which performs focal doubling, and the above-mentioned focal doubling control means were specified as the this specified recording layer While detecting the maximum and the minimum value of a focal error signal corresponding to the recording layer specified with the above-mentioned recording layer assignment means at least A maximum minimum value detection means to once memorize these as maximum data and minimum value data, After the above-mentioned focal doubling is completed, maximum data and minimum value data are read from the above-mentioned maximum minimum value detection means. The focal control unit which has the level adjustment device which adjusts the signal level of the focal error signal supplied from the outside based on this maximum data and minimum value data.
[Claim 2] the difference which detects the difference of the maximum data which read the above-mentioned level adjustment device from the above-mentioned maximum minimum value detection means, and minimum value data -- a detection means and the above -- difference -- the difference from a detection means -- the focal control unit according to claim 1 characterized by to consist of division means adjust signal level by carrying out division processing of the signal about playback of the above-mentioned optical disk with a detection output.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the focal control device aiming at correction of the level variation of a focal error signal produced when it prepares as a focal control system of the multilayer optical disk recording apparatus which performs record playback of record data to multilayer optical disks, such as a magneto-optic-recording mold and a pit record mold, a multilayer optical disk regenerative apparatus, and a multilayer optical disk record regenerative apparatus and the amounts of reflected lights differ for every disk and every recording layer especially about a suitable focal control device etc., for example, it comes to carry out two or more laminatings of the recording layer.
[0002]
[Description of the Prior Art] Generally the conventional optical disk is the monolayer optical disk which has one recording layer. If playback is started, the optical disk regenerative apparatus which reproduces record data from a monolayer optical disk will drive the focal actuator of an optical pickup first by the about 2Hz triangular wave as shown in drawing 6 (a), in order to perform focal doubling. By this, the focus of a laser beam will be changed near the focusing point according to the above-mentioned triangular wave.
[0003] Here, if migration control of such a focus is performed and it becomes a focus just, a sum signal (RF signal) should become more than predetermined level, and the focal error signal should serve as zero level.
[0004] For this reason, the above-mentioned optical disk regenerative apparatus detects a focal error signal as shown in this drawing (c), and detects this level while it detects a sum signal (RF signal) as shown in drawing 6 (b) formed by above-mentioned focal control and compares this with the reference voltage of predetermined level. And the zero level of the above-mentioned focal error signal while the above-mentioned RF signal shown at the time of day t80 of drawing 6 (b) - time of day t82 and time of day t83 - time of day t85 exceeds the level of reference voltage is detected, and this focal error signal shown at the time of day t81 and time of day t84 of this drawing (c) draws a focus servo to the timing used as zero level.
[0005] Thereby, as shown at the time of day t81 and time of day t84 of drawing 7 (a), the above-mentioned focal actuator can draw a focus servo to the timing which reached the focusing point.
[0006] Although it does in this way and a focus servo is drawn, even if the conventional optical disk regenerative apparatus is the optical disk of the same class (or a different class like a compact disk and a magneto-optic disk), a difference is in the amount of reflected lights of a laser beam, respectively, and even if it makes it the level of the above-mentioned focal error signal, for every optical disk, it differs, and it is detected, and has a bad influence on a focus servo.
[0007] For this reason, the conventional optical disk regenerative apparatus carries out division processing of the focal error signal by this RF signal using the above-mentioned RF signal changed according to the amount of reflected lights.
[0008] The level of a different focal error signal for every disk can be equalized by this, and it can

prevent un-arranging [out of which a bad influence comes to a focus servo] by the difference in the level of a focal error signal.

[0009]

[Problem(s) to be Solved by the Invention] Here, in recent years, in order to high-capacity-ize an optical disk, the multilayer optical disk 20 of multilayer structure as shows two or more recording layers to drawing 7 which comes to carry out a laminating is proposed. Between the transparence substrate 60 and the aluminum reflecting layer 65, this multilayer optical disk 20 carries out the laminating of the 1st - the 4th recording layer 61-64, and is constituted. As for the above 1st - the 4th recording layer 61-64, the permeability of light has become small in order, respectively, and the spacers 66-68 of transparence resin are formed between the 1st and 2nd recording layer 61 and 62, respectively between the 2nd and 3rd recording layer 62 and 63 and between the 3rd and 4th recording layer 63 and 64.

[0010] Although a focal actuator is first driven by the triangular wave as shown in drawing 8 (a) when performing focal doubling to such a multilayer optical disk 20, the focus of the laser beam irradiated through the objective lens 26 by this as shown in drawing 9 (a) and (b) will move to each recording layers 61-64 in order. Moreover, since each reflected light from each recording layers 61-64 is irradiated by irradiating a laser beam at the above-mentioned optical disk 20 by the photodetector for RF-signal formation, respectively, a RF signal will be detected in the form where each reflected light from these each recording layers 61-64 lapped as shown in drawing 8 (b).

[0011] For this reason, if the conventional focal control is applied to the above-mentioned multilayer optical disk 20 It is, while the level of this RF signal exceeds the level of reference voltage for the RF signal shown in

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

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[0006] Although it does in this way and a focus servo is drawn, even if the conventional optical disk regenerative apparatus is the optical disk of the same class (or a different class like a compact disk and a magneto-optic disk), a difference is in the amount of reflected lights of a laser beam, respectively, and even if it makes it the level of the above-mentioned focal error signal, for every optical disk, it differs, and it is detected, and has a bad influence on a focus servo.
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[0011] For this reason, if the conventional focal control is applied to the above-mentioned multilayer optical disk 20 It is, while the level of this RF signal exceeds the level of reference voltage for the RF signal shown in drawing 8 (b) as compared with reference voltage. Since the zero level of the focal error signal between time of day t97 and time of day 99 will be detected during time of day t94 and time of day 96 during time of day t91 and time of day 93 during time of day t88 and time of day 90, The focal error signal of a total of four zero level will be detected at the time of day t89 shown in this drawing (c), time of day t92, time of day t95, and time of day t98.

[0012] Therefore, in order to perform focal doubling to a desired recording layer, it is necessary to draw a focus servo to the timing which the focus moved to the desired recording layer out of the four above-mentioned recording layers.

[0013] Moreover, in order to correct the level variation of a focal error signal produced from the difference in the different amount of reflected lights for every disk since in the case of this multilayer optical disk each reflected lights from each recording layers 61-64 overlap and are detected as mentioned above, this RF signal cannot be used for the above-mentioned RF signal, and it cannot perform an exact focus servo.

[0014] This invention aims at offer of the focal control unit which corrects the level variation of a focal error signal produced from the difference in the different amount of reflected lights for every disk, and can perform an exact focus servo, in being made in view of an above-mentioned trouble and being able to perform focal doubling correctly to the recording layer of a request of the optical disk of multilayer structure.

[0015]

[Means for Solving the Problem] A recording layer assignment means for the focal control device concerning this invention to specify the recording layer of the request which performs focal doubling of the optical disk with which it comes to carry out the laminating of two or more recording layers, If a desired recording layer is specified by the above-mentioned recording layer assignment means, in the phase of performing focal doubling to the recording layer by which the focal doubling control means which performs focal doubling, and the above-mentioned focal doubling control means were specified as the this specified recording layer While detecting the maximum and the minimum value of a focal error signal corresponding to the recording layer specified with the above-mentioned recording layer assignment means at least, it has a maximum minimum value detection means to once memorize these as maximum data and minimum value data. Moreover, after the above-mentioned focal doubling is completed, maximum data and minimum value data are read from the above-mentioned maximum minimum value detection means, and it has the level adjustment device which adjusts the signal level of

the signal about playback of the above-mentioned optical disk based on this maximum data and minimum value data.
[0016] moreover, the difference which detects the difference of the maximum data which read the focal control device concerning this invention from the above-mentioned maximum minimum value detection means as the above-mentioned level adjustment device, and minimum value data -- a detection means and the above -- difference -- the difference from a detection means -- it has what consists of division means adjust signal level by carrying out division processing of the focal error signal supplied from the outside with a detection output.
[0017]
[Function] As for the focal control device concerning this invention, assignment of the recording layer of a request of the optical disk to which it comes to carry out the laminating of two or more recording layers by the above-mentioned recording layer assignment means performs focal doubling to the recording layer as which the focal doubling control means was this specified.
[0018] A maximum minimum value detection means is the phase of performing this focal doubling, and it once memorizes these as maximum data and minimum value data while it detects the maximum and the minimum value of a focal error signal corresponding to the recording layer specified with the above-mentioned recording layer assignment means at least.
[0019] And after the above-mentioned focal doubling is completed, a level adjustment device reads maximum data and minimum value data from the above-mentioned maximum minimum value detection means, and adjusts the signal level of the focal error signal supplied from the outside based on this maximum data and minimum value data.
[0020] concrete -- the above-mentioned level adjustment device -- difference -- it constitutes from a detection means and a division means -- having -- **** -- this -- difference -- the difference of the maximum data which read the detection means from the above-mentioned maximum minimum value detection means, and minimum value data -- detecting -- this difference -- an output is supplied to a division means.
[0021] The focal error signal from the outside is supplied to the above-mentioned division means. the above-mentioned division means -- this focal error signal -- the above -- difference -- the difference from a detection means -- signal level is adjusted by carrying out division processing with a detection output.
[0022] For example, when multilayer optical disks of a different class, such as a magneto-optic-recording type and a pit record type, are played, the amounts of reflected lights differ, respectively. Moreover, even if it is the multilayer optical disk of the same class, the amounts of reflected lights differ for this every disk. Furthermore, the amounts of reflected lights from each reflected light of a multilayer optical disk also differ.
[0023] However, by adjusting such signal level, the level variation of a focal error signal produced from the difference in the amount of reflected lights can be corrected without using a RF signal, and an exact focus servo can be performed.
[0024]
[Example] It explains to a detail, referring to a drawing about the desirable example of the focal control unit concerning this invention hereafter.
[0025] The focal control unit concerning the example of this invention has the transfer switch 4 which switches and outputs the input terminal 1 for focal error signals with which the focal error signal from the outside is supplied as shown in drawing 1 , the input terminal 2 for RF signals with which the sum signal (RF signal) from the outside is similarly supplied, the focal search generator 3 which outputs the focal migration signal for focal migration, and the above-mentioned focal error signal and a focal migration signal.
[0026] Moreover, the reference voltage excess detector 5 which the above-mentioned focal control unit compares the focal error signal and reference voltage which are supplied through the above-mentioned input terminal 1, and outputs this comparison pulse, The attainment-near focusing point detector 6 which detects whether it is located near the recording layer of the multilayer optical disk which a focus

explains later based on the RF signal supplied through the above-mentioned input terminal 2, It has the impulse counter 7 which counts the comparison pulse from the above-mentioned reference voltage excess detector 5.
[0027] Moreover, the above-mentioned focal control device has the system controller 11 which outputs the recording layer tbe data which show the recording layer specified by the recording layer specification part 10 and the above-mentioned recording layer specification part 10 for specifying the recording layer of the above-mentioned multilayer optical disk which performs focal doubling as the objective lens migration direction detector 8 which detects the migration direction of the objective lens 26 by which migration control is carried out for focal doubling based on the focal migration signal from the above-mentioned focal search generator 3.
[0028] Moreover, the above-mentioned focal control unit The detection output from the counter value from the above-mentioned impulse counter 7 and the attainment-near focusing point detector 6 and the above-mentioned input terminal 1 are minded. The zero level detector 9 which switches and controls the above-mentioned transfer switch 4 based on the comparison pulse and the above-mentioned recording layer tbe data from a focal error signal and the reference voltage excess detector 5 which are supplied, Based on the counter value from the above-mentioned impulse counter 7, it detects whether the optical disk by which current wearing is carried out is a monolayer optical disk, or it is a multilayer optical disk, and has the monolayer multilayer detector 12 which supplies this detection output to the above-mentioned system controller 11.
[0029] And the maximum detector 13 and the minimum value detector 14 where the above-mentioned focal control unit detects the maximum and the minimum value of a focal error signal corresponding to each recording layer based on the comparison pulse from the above-mentioned reference voltage excess detector 5, The store circuit 15 which once memorizes the maximum data and minimum value data from each above-mentioned detectors 13 and 14, The arithmetic circuit 16 which carries out subtraction processing of the minimum value data from the maximum data read from the above-mentioned storage means, Based on the operation data from the above-mentioned arithmetic circuit 16, it has the focal error standardization circuit 17 which performs standardization processing to the focal error signal supplied through the above-mentioned input terminal 1.
[0030] The focal control device concerning the example which has such a configuration is applicable as a focal control section 36 of an optical disk regenerative apparatus as shown in drawing 2 .
[0031] Hereafter, explanation of the focal control unit (focal control section 36) applied to the example concerned including explanation of this optical disk regenerative apparatus of operation of operation is given.
[0032] First, in drawing 2 , initiation of playback carries out outgoing radiation of the laser beam from a laser light source 21. This laser beam is made parallel light by the collimator lens 22, and incidence is carried out to a diffraction grating 23.
[0033] The optical disk regenerative apparatus concerned detects a tracking error by the so-called 3 spot method. For this reason, the above-mentioned diffraction grating 23 trichotomizes and carries out outgoing radiation of the above-mentioned laser beam to the 0th light and primary [**] light. Incidence of this trichotomized laser beam is carried out to a polarization beam splitter 24.
[0034] Polarization beam splitter film 24a of the above-mentioned polarization beam splitter 24 penetrates the so-called light of P polarization component, and has the property of reflecting the light of S polarization component which has the polarization direction which intersects perpendicularly with these P polarization components. Most laser beams by which incidence of the above-mentioned laser beam was carried out to this polarization beam splitter 24 since most was P polarization component penetrate this polarization beam splitter 24. Incidence of the laser beam which penetrated this polarization beam splitter 24 is carried out to the quarter-wave length plate 25. The above-mentioned quarter-wave length plate 25 circular-polarization-of-light-izes the laser beam of the above-mentioned P polarization component which is the linearly polarized light, and carries out outgoing radiation. This circular-polarization-of-light-ized laser beam converges with an objective lens 26, and is irradiated by the multilayer optical disk 20.

[0035] Next, when a laser beam is irradiated by the above-mentioned monolayer optical disk 20, the reflected light arises. Incidence of this reflected light is carried out to the quarter-wave length plate 25 through the above-mentioned objective lens 26, it is made into the linearly polarized light of S polarization component with this quarter-wave length plate 25, and incidence is carried out to the above-mentioned polarization beam splitter 24.
[0036] As mentioned above, polarization beam splitter film 24a of the above-mentioned polarization beam splitter 24 has the property of reflecting the light of S polarization component. For this reason, it is reflected by this polarization beam splitter 24, and the reflected light of S polarization component by which incidence was carried out to the above-mentioned polarization beam splitter 24 is irradiated by the photodetector 29 through a focusing glass 27 and a collimator lens 28.
[0037] The above-mentioned photodetector 29 consists of the 1st photodetector 45 which receives the reflected light of the 0th light as shown in drawing 3 , and the 2nd and 3rd photodetector 46 and 47 which receives the reflected light of primary [**] light, respectively.
[0038] As for the 1st photodetector 45 of the above, 4th grade division (the light-receiving field A - the light-receiving field D) of the light-receiving field is carried out to the radial the core [an optical axis]. Moreover, as for the 2nd and 3rd photodetector 46 and 47 of the above, one light-receiving field is (the light-receiving field E and the light-receiving field F), respectively.
[0039] Each above-mentioned photodetectors 45-47 form the quantity of light detecting signal according to the quantity of light of the reflected light which received light in each light-receiving field, respectively, and supply these to the tracking error detecting element 30, the focal error detection section 31, and RF signal detection section 32.
[0040] The above-mentioned tracking error detecting element 30 detects a tracking error signal for the quantity of light detecting signal from each light-receiving fields E and F of the 2nd and 3rd photodetector 46 and 47 of the above based on the following operation expression as "E" and "F", respectively.
[0041] Tracking error signal = the tracking error signal detected by E-F, thus the tracking error detecting element 30 is supplied to a current / electrical-potential-difference conversion circuit (I/V conversion circuit) 33. The above-mentioned I/V conversion circuit 33 changes into an electrical potential difference the above-mentioned tracking error signal supplied in the form of a current, and supplies this to the tracking driver 39. The above-mentioned tracking driver 39 drives the tracking coil 40 according to the above-mentioned tracking error signal.
[0042] An objective lens 26 can be driven by this in the direction which corrects a tracking error, and record data can always be just reproduced in the state of a truck.
[0043] Next, the above-mentioned focal error detection section 31 detects a focal error, for example by the so-called astigmatism method, and detects a focal error signal based on the following operation expression by making the quantity of light detecting signal from each light-receiving field A-D of the 1st photodetector 45 of the above into "A-D", respectively.
[0044]
A focal error signal = (A+D)-(B+C)
Thus, the focal error signal detected in the focal error detection section 31 is changed into an electrical potential difference by the I/V conversion circuit 34, and is supplied to the focal driver 41 through the focal control section 36 explained later. The above-mentioned focal driver 41 drives the focal coil 42 according to the above-mentioned focal error signal.
[0045] An objective lens 26 can be driven by this in the direction which corrects a focal error, and record data can always be just reproduced in the state of a focus.
[0046] Next, the above-mentioned RF signal detection section 32 detects a RF signal based on the following operation expression by making the quantity of light detecting signal from each light-receiving field A-D of the 1st photodetector 45 of the above into "A-D", respectively.
[0047] RF signal = the RF signal detected in A+B+C+D, thus RF signal detection section 32 is changed into an electrical potential difference by the I/V conversion circuit 35, and it is supplied to the record data detecting element 37 while the focal control section 36 explained later is supplied. The above-

mentioned record data detecting element 37 detects only the record data from which the regenerative signal of a servo pattern etc. was removed based on the above-mentioned RF signal, and supplies this to external instruments, such as a computer apparatus and loudspeaker equipment, through an output terminal 38.
[0048] The record data reproduced from the above-mentioned multilayer optical disk 20 can be recorded on other record media by this, or it can carry out obtaining the sound output according to these record data etc.
[0049] Here, between the transparence substrate 60 with a thickness of 1.16-1.2mm formed by transparence members, such as a polycarbonate, as shown in drawing 8 , and the aluminum reflecting layer 65 formed with aluminum, the above-mentioned multilayer optical disk 20 carries out the laminating of the 1st - the 4th recording layer 61-64, and is constituted. As for the above 1st - the 4th recording layer 61-64, the permeability of light has become small in order, respectively, and the spacers 66-68 of transparence resin are formed between the 1st and 2nd recording layer 61 and 62, respectively between the 2nd and 3rd recording layer 62 and 63 and between the 3rd and 4th recording layer 63 and 64.
[0050] In addition, if the thickness of each above-mentioned spacers 66-68 is large, it will have a bad influence on an image formation property. For this reason, it is necessary to make thickness of each above-mentioned spacers 66-68 into within the limits suppliable with the image formation property of an objective lens, and when it is this example, it serves as thickness which is 35-40 micrometers.
[0051] When reproducing record data from such a multilayer optical disk 20, it is necessary to perform focal doubling to a desired recording layer in advance of playback first. For this reason, a user specifies the recording layer of the request reproduced by operating the recording layer specification part 10 shown in drawing 1 . If a desired recording layer is specified by the user, the above-mentioned system controller 11 will detect this, will serve as focal search mode, it supplies the recording layer tbe data corresponding to the specified recording layer to the above-mentioned zero level detector 9, and it carries out drive control of the above-mentioned focal search generator 3 so that the triangular wave for a focal search may be generated, while it switches and controls a transfer switch 4 to choose selected terminal 4b by selection terminal 4c.
[0052] If a focal search is specified from the above-mentioned system controller 11, for example, it seems that the above-mentioned focal search generator 3 is shown at the time of day t1 of drawing 4 (a) - time of day t32 and the time of day t32 of drawing 5 (a) - time of day t63, a triangular wave signal with a frequency of about 2Hz will be formed, and it will supply this to selected terminal 4b of the above-mentioned transfer switch 4. As mentioned above, at the time of this focal search mode, to choose selected terminal 4b by the above-mentioned selection terminal 4c, the above-mentioned transfer switch 4 switches and is controlled. For this reason, the triangular wave signal supplied to the above-mentioned selection terminal 4b is supplied to the focal coil 42 through the focal driver 41 shown in drawing 2 through a transfer switch 4.
[0053] According to the above-mentioned triangular wave signal, migration control of the above-mentioned objective lens 26 is carried out by this in the direction of a path of the multilayer optical disk 20, and the direction which intersects perpendicularly. The focus of a laser beam will move in order of the 1st recording layer 61 - the 4th recording layer 64 between the time of day t1 of drawing 4 (a) - time of day t32, and it will move in order of the 4th recording layer 64 - the 1st recording layer 61 between the time of day t32 of drawing 5 (a) - time of day t63. Moreover, in the above-mentioned focal error detection section 31 and RF signal detection section 32, the focal error signal and RF signal according to focal migration of this laser beam are detected. And the above-mentioned focal error signal is supplied to selected terminal 4a, the reference voltage excess detector 5, and the zero level detector 9 of a transfer switch 4 through an input terminal 1, and the above-mentioned RF signal is supplied to the attainment-near focusing point detector 6.
[0054] The above-mentioned reference voltage excess detector 5 carries out the level comparison of the focal error signal which sways to positive/negative on the basis of the zero level which is the level at the time of a focus just as shown in drawing 4 (c) and drawing 5 (c) with forward reference voltage (the 1st

reference voltage). During during during during time of day t3 - time of day t5 and time of day t10 which it is while this focal error signal becomes more than the 1st reference voltage - time of day t12, time of day t17 - time of day t19, time of day t24 - time of day t26, and during during during time of day t38 - time of day t40, time of day t45 - time of day t47, time of day t52 - time of day t54, time of day t59 - time of day t -- to ... 61 between The 1st comparison pulse as shown in drawing 4 (d) and drawing 5 (d), respectively is formed, and this is supplied to an impulse counter 7, the zero level detector 9, and the maximum detector 13.

[0055] Moreover, the above-mentioned reference voltage excess detector 5 carries out the level comparison of the above-mentioned focal error signal with negative reference voltage (the 2nd reference voltage), as shown in drawing 4 (c) and drawing 5 (c). During during during time of day t7 - time of day t9 and time of day t14 which it is while this focal error signal becomes below the 2nd reference voltage - time of day t16, time of day t21 - time of day t23, During during during during time of day t28 - time of day t30 and time of day t34 - time of day t36, time of day t41 - time of day t43, time of day t48 - time of day t50, time of day t55 - time of day t -- the 2nd comparison pulse as shown in ... 57 between at drawing 4 (e) and drawing 5 (e), respectively is formed, and this is supplied to an impulse counter 7, the zero level detector 9, and the minimum value detector 14.

[0056] In addition, the above 1st and the 2nd comparison pulse of four shots are formed at a time, respectively, since the above-mentioned multilayer optical disks 20 are 4 layer structures while the above-mentioned focus moves to the 1st recording layer 61 - the 4th recording layer 64, and while the above-mentioned focus moves to the 4th recording layer 64 - the 1st recording layer 61.

[0057] Here, since a focus suits in order, applying [time of day / t32 / the time of day t1 of above-mentioned drawing 4 (a) -] it to the 4th recording layer 64 from the 1st recording layer 61 when migration control of the objective lens 26 is carried out by the triangular wave signal as mentioned above, the above-mentioned focal error signal is detected in order of forward level and negative level on the basis of the zero level which is the level at the time of a focus just as shown during this time of day of drawing 4 (c). Conversely, since [this] a focus suits in order, applying [time of day / t63 / the time of day t32 of above-mentioned drawing 5 (a) -] it to the 1st recording layer 61 from the 4th recording layer 64, the above-mentioned focal error signal is detected in order of negative level and forward level on the basis of the zero level which is the level at the time of a focus just as shown during this time of day of drawing 5 (c).

[0058] Therefore, while this focus is applying and moving to the 4th recording layer 61 from the 4th recording layer 64 while the focus is applying and moving to the 4th recording layer 64 from the 1st recording layer 61, the comparison pulse of the above 1st and the 2nd comparison pulse will get mixed up in time, and will be detected.

[0059] Although explained later The focal control unit concerning this example detects the zero level of the focal error signal detected by the beginning after the comparison pulse corresponding to the specified recording layer was supplied. Since he is trying to switch and control the above-mentioned transfer switch 4 by timing by which this zero level was detected, While the focus is applying and moving to the 4th recording layer 64 from the 1st recording layer 61 While a focus is missing from the 1st recording layer 61 from the 4th recording layer 64 conversely using the comparison pulse of the above 1st detected previously in time and moving, it is necessary to use the comparison pulse of the above 2nd detected previously in time.

[0060] For this reason, the objective lens migration direction detector 8 detects the migration direction of an objective lens 26 based on the polarity of the focal migration signal supplied from the above-mentioned focal search generator 3 at the time of this focal search mode, and supplies this migration direction detecting signal to the above-mentioned impulse counter 7 and the zero level detector 9.

[0061] Specifically the above-mentioned objective lens migration direction detector 8 While the focus is applying and moving to the 4th recording layer 64 from the 1st recording layer 61 As shown at the time of day t1 of drawing 4 (b) - time of day t32, the high-level migration direction detecting signal is outputted, and while the focus is applying and moving to the 1st recording layer 61 from the 4th recording layer 64, as shown at the time of day t32 of drawing 5 (b) - time of day t63, the migration

direction detecting signal of a low level is outputted.
[0062] The above-mentioned impulse counter 7 counts the pulse number of the comparison pulse of the above 1st between two comparison pulses from the reference voltage excess detector 5, while the migration direction detecting signal of the above-mentioned high level is supplied, and while the migration direction detecting signal of the above-mentioned low level is supplied, it counts the pulse number of the comparison pulse of the above 2nd. And this counted value is supplied to the zero level detector 9 and the monolayer multilayer detector 12, respectively.
[0063] Moreover, the pulse number of the comparison pulse counted by the above-mentioned impulse counter 7 While being moved to the 4th recording layer 64 - the 1st recording layer 61 while a focus is moved to the 1st recording layer 61 - the 4th recording layer 64 and counting separately The counted value from the impulse counter 7 supplied to the zero level detector 9 needs to show that a focus is detected during migration between the above 1st - the 4th recording layer 61-64.
[0064] In the case of the optical disk of multilayer structure, since the reflected light arises from each recording layer, as a RF signal is shown in drawing 4 (f) and drawing 5 (f), the reflected lights from each recording layer overlap, and are detected, but The above-mentioned attainment-near focusing point detector 6 by carrying out the level comparison of this RF signal and reference voltage during the time of day t2 of drawing 4 (g) - time of day t15 and the time of day t33 of drawing 5 (g) - time of day t -- as [show / in ... / 62 between] -- The above-mentioned focus forms the attainment-near focusing point detecting signal which shows that it is located between the 1st recording layer 61 - the 4th recording layer 64, and supplies this to an impulse counter 7 and the zero level detector 9.
[0065] the above-mentioned impulse counter 7 -- the time of day t15 of drawing 4 (g), and the time of day t62 of drawing 5 (g) -- counted value is reset in falling of an attainment-near focusing point detecting signal shown in ..., and a new count is started from here. Thereby, while a focus moves to the 1st recording layer 61 - the 4th recording layer 64, and while moving to the 4th recording layer 64 - the 1st recording layer 61, the above 1st or the 2nd comparison pulse of four shots is correctly countable at a time, respectively.
[0066] In this way next, to the zero level detector 9 The counted value from an impulse counter 7, If the recording layer tbe data from the attainment-near focusing point detecting signal, the migration direction detecting signal from the objective lens migration direction detector 8, and the above-mentioned system controller 11 from the 1st from the reference voltage excess detector 5, the 2nd comparison pulse, and the attainment-near focusing point detector 6 are supplied, respectively This zero level detector 9 detects the counted value from the impulse counter 7 corresponding to this specified recording layer while detecting the recording layer which performs first focal doubling specified by the user based on the above-mentioned recording layer tbe data. Moreover, based on the above-mentioned attainment-near focusing point detecting signal, and the migration direction detecting signal, the above 1st or the 2nd comparison pulse is counted.
[0067] And the focal error signal after the above 1st supplied when the counted value corresponding to the recording layer by which assignment was carried out [above-mentioned] is supplied, or the 2nd comparison pulse switches and controls the above-mentioned transfer switch 4 by timing which serves as zero level at the beginning to choose selected terminal 4a by selection terminal 4c.
[0068] When the 2nd recording layer 62 of the above is specified by the user and the above-mentioned focus is specifically moving to the 1st recording layer 61 - the 4th recording layer 64, as for the above-mentioned zero level detector 9, the counted value of "2" from the above-mentioned impulse counter 7 is detected. And with the counted value of the above "2", after the 1st comparison pulse shown from the reference voltage excess detector 5 during the time of day t10 of drawing 4 (d) - time of day t12 is supplied, a focal error signal switches and controls the above-mentioned transfer switch 4 by timing of the time of day t13 of this drawing (c) used as zero level to the beginning.
[0069] Similarly, when the 1st recording layer 61 of the above, the 3rd recording layer 63, or the 4th recording layer 64 is specified by the user, the above-mentioned transfer switch 4 is switched and controlled by timing of the time of day t6 of drawing 4 (c), time of day t20, and time of day t27, respectively.

[0070] Moreover, when the 3rd recording layer 63 of the above is specified by the user, for example and the above-mentioned focus is moving to the 4th recording layer 64 - the 1st recording layer 61, as for the above-mentioned zero level detector 9, the counted value of "3" from the above-mentioned impulse counter 7 is detected. And with the counted value of the above "3", after the 2nd comparison pulse shown from the reference voltage excess detector 5 during the time of day t41 of drawing 5 (e) - time of day t43 is supplied, a focal error signal switches and controls the above-mentioned transfer switch 4 by timing of the time of day t51 of this drawing (c) used as zero level to the beginning.
[0071] Similarly, when the 1st recording layer 61 of the above, the 2nd recording layer 62, or the 4th recording layer 64 is specified by the user, the above-mentioned transfer switch 4 is switched and controlled by timing of the time of day t37 of drawing 4 (c), time of day t44, and time of day t58, respectively.
[0072] The focal error signal supplied through the above-mentioned input terminal 1 is supplied to selected terminal 4a of the above-mentioned transfer switch 4. For this reason, a focal error signal will be supplied to the focal coil 42 shown in above-mentioned drawing 2 to above-mentioned timing.
[0073] A focus servo can be applied to a desired recording layer by this to the timing whose focus suits, and focal doubling can be performed to a desired recording layer.
[0074] Next, the counter value from the above-mentioned impulse counter 7 is supplied also to the monolayer multilayer detector 12. When the counter value supplied from the above-mentioned impulse counter 7 when the objective lens 26 was driven as mentioned above and the optical disk with which it was equipped is a monolayer optical disk which has one recording layer is only one and the optical disk with which it was equipped is a multilayer optical disk which has two or more recording layers, as for the counter value supplied from the above-mentioned impulse counter 7, the counter value for this recording layer should be supplied. For this reason, by detecting whether two or more supplies of the counted value from the above-mentioned impulse counter 7 are carried out, the above-mentioned monolayer multilayer detector 12 detects whether the optical disk by which current wearing is carried out is a monolayer optical disk, or it is a multilayer optical disk, and supplies this detection output to the above-mentioned system controller 11.
[0075] The above-mentioned system controller 11 carries out the display control of the display panel so that the classification (is it a monolayer or is a multilayer?) of the optical disk with which it was equipped may be displayed based on the above-mentioned detection output. Moreover, gain of each above-mentioned I/V conversion circuits 33-35 is switched with a monolayer optical disk and a multilayer optical disk.
[0076] In addition, since the counted value of 1-4 is supplied, for example in the case of the multilayer optical disk of 4 layer structures, this is detected, and the recording layer by which displays the number of recording layers or current focus doubling is carried out may be displayed, or it may be made to perform a switch of the servo gain according to a recording layer etc.
[0077] Here, even if it is the multilayer optical disk of the same class, a difference is in the amount of reflected lights for every disk, and the amounts of reflected lights differ for every recording layer. For this reason, the level of the focal error signal detected will also differ for every multilayer optical disk and recording layer, and, the way things stand, has a bad influence on an exact focal error signal.
[0078] Although fluctuation of this focal error signal was conventionally corrected based on the level of a RF signal, since in the case of the above-mentioned multilayer optical disk each reflected lights from each recording layers 61-64 overlap as mentioned above and a RF signal is detected, a RF signal cannot be used for correction of fluctuation of this focal error signal.
[0079] In order that the focal control device concerning this example may prevent such un-arranging, he detects the level of a focal error signal for every recording layer at the time of the above-mentioned focal search mode, and is trying to correct fluctuation of a different focal error signal for every disk and every recording layer according to this detected level.
[0080] That is, the 1st comparison pulse which compared the focal error signal and the 1st reference voltage of forward level, and was formed in the reference voltage excess detector 5 at the time of the above-mentioned focal search mode is supplied to the maximum detector 13, and the 2nd comparison

pulse which compared the focal error signal and the 2nd reference voltage of negative level, and was formed in this reference voltage excess detector 5 is supplied to the minimum value detector 14.
[0081] The focal error signal supplied through an input terminal 1, respectively is supplied to each above-mentioned detectors 13 and 14.
[0082] if, as for the above-mentioned maximum detector 13, the comparison pulse of the above 1st is supplied -- the time of day t4 of drawing 4 (c), time of day t11, time of day t18, and time of day t25 -- or it is shown at the time of day t39 of drawing 5 (c), time of day t46, time of day t53, and time of day t60 -- this -- the maximum of the focal error signal corresponding to each recording layers 61-64 while the 1st comparison pulse is supplied is detected, and each of this maximum detection data is supplied to a store circuit 15, respectively.
[0083] if, as for the above-mentioned minimum value detector 14, the comparison pulse of the above 2nd is supplied -- the time of day t8 of drawing 4 (c), time of day t15, time of day t22, and time of day t29 -- or it is shown at the time of day t35 of drawing 5 (c), time of day t42, time of day t49, and time of day t56 -- this -- the minimum value of the focal error signal corresponding to each recording layers 61-64 while the 2nd comparison pulse is supplied is detected, and each of this minimum value detection data is supplied to a store circuit 15, respectively.
[0084] The above-mentioned store circuit 15 once memorizes the maximum data and minimum value data corresponding to each above-mentioned recording layers 61-64.
[0085] Next, the above-mentioned focal search mode is completed, to read the above-mentioned maximum data and minimum value data corresponding to the recording layer shown by the recording layer tbe data from the above-mentioned recording layer specification part 10, the above-mentioned store circuit 15 will be read and the above-mentioned system controller 11 will be controlled, if a transfer switch 4 is switched and controlled and a focus servo is drawn. When the 2nd recording layer 62 is specified by the above-mentioned recording layer specification part 19, to read the above-mentioned maximum data and minimum value data which were formed corresponding to this 2nd recording layer 62, the above-mentioned store circuit 15 is read and, specifically, the above-mentioned system controller 11 is controlled.
[0086] This maximum data and minimum value data are supplied to an arithmetic circuit 16, respectively.
[0087] the above-mentioned arithmetic circuit 16 -- the difference of the above-mentioned maximum data and minimum value data -- detecting -- this difference -- data are supplied to the focal error standardization circuit 17.
[0088] the focal error signal to which the above-mentioned focal error standardization circuit 17 is supplied through the above-mentioned input terminal 1 -- the above -- difference -- division processing is carried out by data and this is supplied to the focal coil 42 through the above-mentioned transfer switch 4.
[0089] The level of the above-mentioned focal error signal is changed according to the different amount of reflected lights for every above-mentioned disk and every recording layer. For this reason, fluctuation of every disk and the focal error signal for every recording layer can be corrected by detecting the maximum and the minimum value of a focal error signal, and carrying out division processing of the focal error signal by this difference, without using a RF signal.
[0090] Therefore, when the disk with which the amounts of reflected lights differ was played, or even when the recording layer from which the amount of reflected lights differs is reproduced, a focus servo can be performed on average level and an exact focus servo can be performed.
[0091] In addition, although [explanation of an above-mentioned example] the focal control device concerning this invention is applied to an optical disk regenerative apparatus, this may be applied to for example, an optical disk recording apparatus or an optical disk record regenerative apparatus.
[0092] Moreover, based on the maximum and the minimum value of a focal error signal although the level variation of a focal error signal is corrected, you may make it this correct the level variation of other signals, such as for example, a tracking error signal and a regenerative signal.
[0093] Moreover, although [the above-mentioned optical disk 20 / record data] it is the optical disk

beforehand formed in the shape of a pit, if this is multilayer structure, it is natural. [of other optical disks, such as a magneto-optic disk, being sufficient]
[0094]
[Effect of the Invention] The focal control device concerning this invention can correct the level variation of a focal error signal, when record playback of the multilayer optical disk with which the amounts of reflected lights differ is carried out, or even if it is the case where record playback of the multilayer optical disk with which the amounts of reflected lights from each recording layer differ is carried out.
[0095] For this reason, an exact focus servo can be made possible.

[Translation done.]